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NOTES ON THE LIFE-HISTORY OF *CHOROPHILUS*
TRISERIATUS.

BY O. P. HAY.

ON the 22d day of last March, while searching the ponds about Irvington, Indiana, for *Amblystomas* and their eggs, I discovered some amphibian spawn whose parentage I did not then recognize; but which, after hatching, development, and metamorphosis, proved to be that of the little frog, *Chorophilus triseriatus*.

The eggs were deposited in an admirable situation for making observations upon them. A large tree, standing at the edge of a shallow temporary pond, had been overthrown; and when the roots had been buried, a hole some two feet deep had been left, and this was full of water. It was so cut off from the pond that by arranging a few sticks and leaves it was made very difficult both for the tadpoles coming from these eggs to leave the pool and for those of the other species to enter it. There were large numbers of the eggs, hundreds of them; but whether or not all had been deposited by a single female, I could not tell. The species is here apparently rare, but a single specimen having been captured. Many such animals, however, have a faculty for concealing themselves for years; until some lucky accident, or an unusually close search, reveals to us their real abundance.

The eggs were deposited in bunches of various sizes and were attached to branches and twigs which had fallen into the water. They clung to one another and to the twigs by means of the clear jelly that surrounded each egg. They had already gone well forward in their development, since each contained a larva of the form shown in Figure 1. It will be seen that the dorsal flexure is very pronounced, and the tail is thrown over the back. The diameter of each egg is about 3 mm.

Figure 2 represents the larva as it appears on the 28th day of March. It is now 5 mm. long, and has lost its dorsal flexure, but is coiled laterally within the egg membranes. Sections show the

nasal pits formed, the eye-balls beneath the skin, and the auditory organs as simple hollow cavities. There is no mouth, only a depression where the mouth will be. The "suckers," or "holders," are fully developed.

By the 5th of April the tadpoles had escaped and were swimming about in the pool. The mouth is not yet perforated, there are no gill slits, and the gills themselves appear as mere buds. It does not appear that they ever become important organs. The holders are present, but they seem scarcely as prominent as they were in the unhatched young. The larvæ are thin from side to side, and slenderer than are those of *Rana virescens* at the same stage. They are of a yellowish gray color, with punctulations of black. It is with great difficulty that, in sections, one can make out the cartilaginous lower jaw, the hyoid, and one or two branchial arches.

On the 11th of April the young have reached a length of 7.5 mm. The body is becoming broader and more pear-shaped, owing to the growth of the intestine. The eyes are completed; the iris is of a golden color. The back is now flecked with golden dots. They spend much of their time sticking to the sides of the aquarium, but it is probably not by means of their holders, since sections taken two days later show that these have disappeared. No external gills are visible; neither could I observe that water was being taken in. Sometimes when disturbed they would start off and spin round and round in the water for awhile before taking any definite course. By the rapid streaming of water over the body it was evident that a vigorous ciliary action was going on.

On the 13th the external gills were gone, water was to be seen streaming through the nostrils and out through the pore on the left side, which alone appeared to be open. The body is pear-shaped. The back is black, speckled with gold; the belly is also black and gold except along the middle line, where it is transparent enough to show the coils of intestines. The now open mouth is triangular, and the jaws furnished with black, minutely denticulated, horny sheaths. One specimen examined had these alone; another had, in addition, two rows of black horny teeth on the

lower lip. The convoluted intestines are loaded with fine sand and vegetable débris. The cartilaginous structures of the head have undergone astonishing development since the 5th.

By April 20 the length has become 10 mm. There is a bud of tissue on each side at the base of the tail, the rudiment of the future hinder limbs. The mouth is nearly surrounded by a row of fleshy papillæ, inside of which are the rows of horny labial teeth. There are now two rows on each lip, the one next the upper beak being interrupted in the middle line. All these teeth are finely notched at their tops, the whole forming a most admirable apparatus for scraping off the layer of algæ that covers everything in the water. Ciliary action is still going on over the body.

A week later the length has increased a little. By means of their sucker-like mouths they adhere to the vessel in which they are kept. They are probably at the same time busy feeding. The lower lip is now provided with three rows of denticles, a third short row having made its appearance outside of the others. The eyes are more lateral than are the *Rana virescens* larvæ.

Measurement of the tadpoles on the 4th of May shows their length to be 19 mm. The hinder limbs show signs of segmentation. The body is jet black, with dots of gold; the belly is nearly covered with gilt of a brassy reflection. In one specimen currents of water were seen to enter the nostrils, and feebler currents the mouth. One was seen to come to the surface for air, and others to emit bubbles of air beneath the water. Observation of these larvæ and those of *Acris gryllus* shows that the water used in breathing is drawn in through the nostrils and emitted through the pore on the left side until about the time when the forelegs are to appear. It is then drawn in, principally, at least, by the mouth. I have also observed in the case of both species that after the forelegs have been set free and the tail begins to be observed at least a portion of the water taken in by the mouth is sent out by the nostrils. This may be due to the partial closing up of the excurrent branchial pore. The stream may bathe the yet present gills; but if the water continues thus to be drawn in and expelled after the gills are absorbed, as I have

reason to think it does, we shall have then a sort of pharyngeal respiration such as Profs. Gage have observed in *Aspidonectes* and *Cryptobranchus*, and myself in three species of *Amblystoma*. This mode of respiration in the frogs named, if it really is such, differs from that in *Amblystoma* in that in the latter the water enters by the nasal passages and leaves by the mouth.

It may be proper here to describe the labial dentary apparatus of *Chorophilus* as compared with that of *Acris*, as we find it in maturer tadpoles of both. In *Acris* there seem to be but four rows of denticles, two on the upper and two on the lower lip; while, as already said, in *Chorophilus* there is a short third row on the lower lip. In the former species the teeth are not notched at their tips; in the latter each tooth is notched at the tip so as to present about eight little points. The teeth are also more numerous in *Chorophilus* than in *Acris*. This may be most briefly presented as follows:

Number of Teeth.	Chorophilus.	Acris.
In outer, or upper, row of upper lip .	90	50
" inner or lower " " " .	80	44
" " or upper " lower " .	85	57
" second " " " .	95	60
" third " " " .	55	—

By the 26th of May the tadpoles had attained a length, in some cases, of 27 mm., 16 of which is tail. Many of them about this time succeeded in releasing their fore limbs from the skin which bound them down. There was so much difference in size among them that I was quite convinced that tadpoles of other species had invaded the pool; but this proved not to be the case. The difference was principally in size and plumpness; but it was evident that as soon as the fore-legs were released, and even before, there was a reduction in the animal's bulk.

These four-legged tadpoles were very lively and very timid, and darted about in great alarm when disturbed. They would also crawl out of the water on stones in the aquarium, and sit there in great contentment. They were also perfectly ready to leap out upon the table or the floor. It was easy to see even at

this period that they belonged to some species of tree-frog, since the hinder digits were furnished with disks ; as were also the fingers even before they were set free. No stripes were yet visible. As the tail shows signs of absorption the body continues to shrink in size, probably owing to the shortening of the alimentary canal. The dorsal stripes also begin to appear, so that it becomes easy to recognize the species.

They now show a decided inclination to leave the water. They climb up the sides of the aquarium ; and to keep them in netting must be put over it. Having no web on their feet, they are poor swimmers, and many of them were found drowned. When free they doubtless early leave the water, and hide away among the sticks and leaves, where they are protected, and can find suitable food.

By the first of June many of the larvæ had lost nearly the whole of the tail. Others were slower in development, and it was not until the 12th of June that all had completely transformed. Twenty-five or thirty of these were shut up in a box containing dirt and chips, and covered with netting. An attempt was made to furnish them with insect food, with the intention of watching them further. They hid away under the chips, and lived for some days ; but they grew emaciated, and many died, and the effort to raise them was abandoned.

I doubt much that this species is, to any considerable extent, a tree-inhabiting frog. Such specimens as have been taken where I could learn of the circumstances have been captured in the grass. Dr. Coues states, in the " Bulletin of the U. S. Geological Survey," IV., p. 290, that it was found in the greatest abundance in prairie pools and streams in Northern Dakota and Montana. Some of them were taken at Frenchman's river on the 1st of July. It is probable that even at that late season they were depositing their spawn.

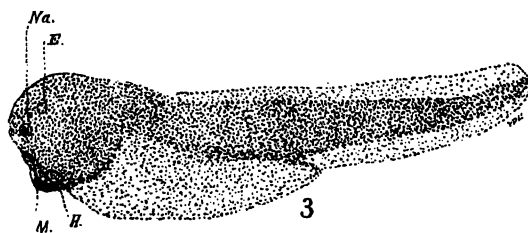
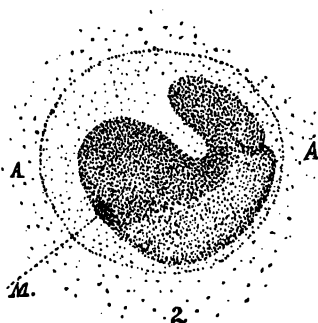
EXPLANATION OF PLATE XXXV.

FIG. 1. Adult frog of natural size.

FIG. 2. Egg on March 22, with contained larva. A, gelatinous envelope around egg ; M, mouth.

FIG. 3. Larva on 28th of March, straightened ; Na, external nares ; E, eye ; M, mouth ; H, holders.

PLATE XXXVI.



Chorophilus triseriatus.